

Three-Phase Grid Connection

with **SUNNY MINI CENTRAL**



Contents

The inverters of the Sunny Mini Central product family have been especially conceived for their use in three-phase feed-in systems. This technical information contains important material on the symmetrical grid operation of these systems as well as on the requirements which have to be taken into account during their design.

1 Connection Principle

By joining three Sunny Mini Centrals into a group, a three-phase feed-in system can be established which takes the country-specific limits for unbalanced loads into account¹. If, when considering the unbalanced loads, a distinction is made between a design based on the assumption of fault-free operation² and a design which assumes the possibility of a fault³, or if more protective measures are needed in the case of particular installations, additional requirements for the system could arise.

In order to react with flexibility to the requirements of the utility operator as well as to the regulations in force in the country where the system will be implemented, all Sunny Mini Centrals are equipped with the innovative Power Balancer®. With it, three inverters can be connected to each other respectively. This way, a three-phase "unit" is formed which, technically, is no different from a three-phase inverter.

2 Regulations in Germany

In Germany, the following regulation must be met when designing a system or when connecting it to the grid:

- VDEW regulation – Power-Generating Systems on the Low-Voltage Grid, March 2004, 4th amended edition.

The following requirements for connection to the grid follow from this regulation:

Systems up to 30 kVA

- The unbalanced load in the normal operation (4.6 kVA) must be observed.
- The Power Balancer is not needed.
- A disconnection point which is accessible at all times is not necessary.
- Single-phase inverters can feed in independently from each other.
- An external ENS is not necessary. The individual ENSs of the inverters are approved. (ENS = Grid-monitoring device with its all-pole circuit breakers in series.)

Example: a 30 kVA PV system with 3 x Sunny Mini Central 10000 TL is possible, without the Power Balancer.

¹ Total asymmetry between the external conductors.

² System design which assumes fault-free operation

³ System design which considers the possibility of a fault: "Fehlerfall".

Systems > 30 kVA

- The unbalanced load in the normal operation (4.6 kVA) must be observed.
- A disconnection point which is accessible at all times is necessary.
- A three-phase voltage monitor with overvoltage and reverse current protection and a circuit breaker is needed:

By creating the feed-in units and activating the Power Balancer function (operating mode in Phase Guard or Fault Guard), a three-phase voltage monitor for every feed-in unit can be implemented. Additional operational safety is achieved through the internal circuit breaker, the function of which is tested before every starting procedure.

- By arrangement with the utility operator, an externally implemented "three-phase voltage monitor with circuit breaker" can be dispensed with, under certain circumstances.

Example: a 99 kVA PV system with 3 x 33 kW feed-in units. Each unit consists of 3 x SMA 11000TL; the 3-phase quality is achieved by the Power Balancer through the electric connection of the inverters.

3 What to do, when additional measures are required?

When seeking a permit for a PV system, the technical connection requirements (TCR) of the appropriate utility operator must be observed, in addition to the applicable state regulations in the country of installation. In these situations and under certain circumstances different declarations or interpretations can lead to difficulties in obtaining the permit for the system. The activation of the Power Balancer function can be of aid in these cases. Through the activation, the following fundamental system properties are achieved:

"Three-phase quality": this is achieved through the electrical connection of three single-phase inverters into a three-phase feed-in unit.

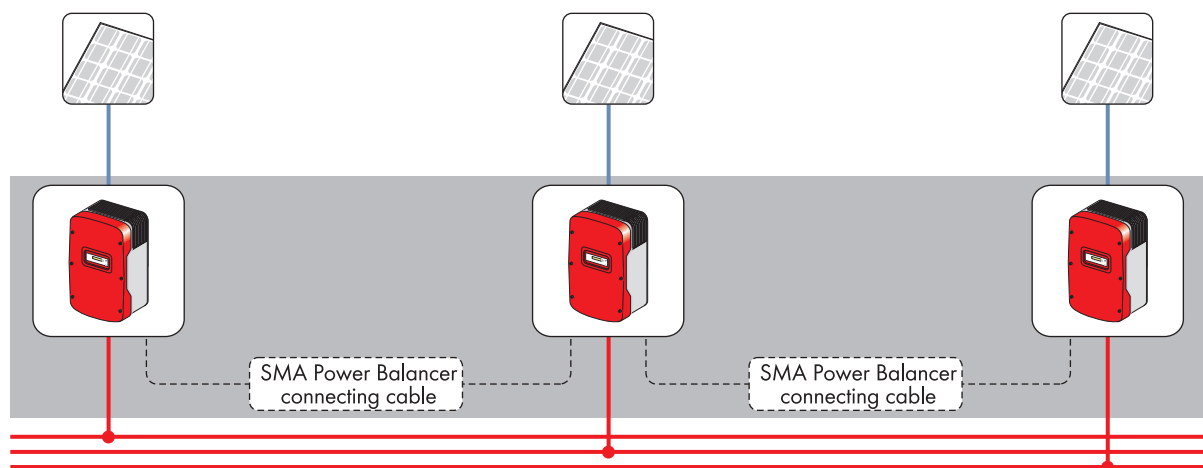
"The highest operational safety": by means of the "Fail-safe operation", the entire feed-in unit is switched off, or the feed-in is reduced to the highest unbalanced load allowed, if there is an unintended interruption in the electrical connection between the partial systems.

Additional flexibility is afforded by the different operating modes of the Power Balancer. Here, the reaction of the feed-in unit to grid or device failures can be tailored to the corresponding utility operator's requirements.

The Power Balancer's operating modes can be placed in the following four levels:

<p>Phase 1</p>	<p>Feed-in unit with systems independent from one another, operational mode "off"</p> <ul style="list-style-type: none"> • The feed-in of the unbalanced load in case of an error is possible, since feed-in continues in the phases not affected. • Minimal yield losses in case of error.
<p>Phase 2</p>	<p>Feed-in unit with Power Balancer in "Power Guard" operating mode.</p> <ul style="list-style-type: none"> • In case of grid error or a device failure the feed-in unit continues to feed a maximum of 5 kVA in the phases not affected. • The unbalanced load is limited to a maximum of 5 kVA.
<p>Phase 3</p>	<p>Feed-in unit with Power Balancer in "Phase Guard" operating mode.</p> <ul style="list-style-type: none"> • The Power Balancer substitutes a three-phase voltage monitoring. • As in the case of external voltage monitoring, disconnection of the feed-in unit only takes place in case of grid errors.
<p>Phase 4</p>	<p>Feed-in unit with Power Balancer in "Fault Guard" operating mode.</p> <ul style="list-style-type: none"> • Appearance of an asymmetrical feed-in is avoided by means of immediate disconnection of the feed-in unit, in case of grid error (three-phase monitoring) or device failure. • An advantage when compared to externally implemented voltage monitoring is that an unbalanced load will not be generated even in the case of a device failure. An external solution can only detect grid errors.

Three-phase feed-in unit with electrical connection through the Power Balancer®



By using a multitude of the feed-in units mentioned above, large systems in up to the Megawatt range with symmetrical grid operation can be achieved.

How is the Power Balancer activated?

Device connection

The Power Balancer function is already integrated in all Sunny Mini Central units. For this purpose, all the inverters are equipped with an internal terminal connection, with which three devices in each case can be connected with a simple communication cable. In this case one of the inverters must be configured as "master" (jumper).

The new SMC 9000TL-10/10000TL-10/11000TL-10 are fitted with a plug system for connection. The electrical connection of three devices is carried out in the case of these inverters using a prefabricated connection cable (order number PBL-YCABLE-NR). The designation of a "master" is not necessary here.

Activation of the desired operating mode

The behavior of the three-phase feed-in system in case of a device failure or grid error can be determined by an installer by means of operating parameters. These adjustments can be carried out using SMA Solar Technology communication products. An additional password offers more security here.

You can find more information in the documentation of your Sunny Mini Central and in the "Declaration on three-phase voltage monitoring by means of the Power Balancer", Source: www.SMA.de.

4 References



Title image: Gehrlicher Solar AG

"Ecoparque Solar de Bullas" (5 MW):
Largest CdTe thin-film system in Spain.
250 three-phase feed-in units made up of
750 Sunny Mini Central 7000HV inverters.



Images: SMA Solar Technology AG

"Energiepark Fünfstetten", Fünfstetten (1.67 MWp):
The largest PV system using silicon thin-film technology.
27,945 Kaneka K60 thin-film modules and
228 Sunny Mini Central 6000A inverters

Operator:

Erstes Bürgersolarkraftwerk Fünfstetten GmbH & Co. KG

Planning and implementation:

IBC Solarstrom Verwaltungs GmbH, IBC Solar AG



Images: Schletter Solar Montagesysteme GmbH

PV system on the Schletter company building (1.33 MW):
18,298 thin-film modules and
109 Sunny Mini Central 11000TL inverters.